INTRODUCTION

The primary considerations in anaesthetic management of ophthalmic surgeries are the following:

- An immobile eye with extraocular muscle akinesia
- Control of the Airway with adequate ventilation
- Haemodynamic stability
- Well Controlled intraocular pressure by avoiding raise in the central venous pressure prior to, during and after the surgery.

In a procedure involving a pure extraocular procedure, eg. Strabismus correction, there is no impact on the conduct of the surgery. In a closed intraocular procedure, eg. Vitrectomy the intraocular pressure is controlled by the ophthalmic surgeon manometrically. At the same time, in open ophthalmic procedures such as traditional intracapsular cataract extraction or in drainage operations in glaucoma, it is crucial that intraocular pressure is kept in control. On surgical incision of the sclera the intraocular pressure approximately equals the atmospheric pressure. It is desirable to have a low-normal intraocular pressure prior to surgical incision.

Sudden decompression of a hypertensive eye may be catastrophic with iris or lens prolapse, vitreous loss or expulsive choroidal haemorrhage. These procedures, and the repair of penetrating eye injuries, present special challenges to the anaesthetist and proper anaesthetic management contributes significantly to a successful surgical outcome. In general, most of the ophthalmic surgeries done in children are under general anesthesia. General anaesthesia with endotracheal intubation is a time-tested procedure and most routinely practiced all over the world. Most commonly the general anesthesia was given by using endotracheal intubation. The procedure has evolved over many years. The procedure of laryngoscopy and endotracheal intubation is associated with pressor response and rise in intraocular pressure. It is characterised by increase in heart rate, transient rise in blood pressure and rise Intraocular pressure. Though this phenomenon is transitory and returns to normal, is not significant in healthy normal patients. To obtund such response, both pharmacological and non- pharmacological methods have been attempted. . A closed eye will normally withstand a short increase of intraocular pressure. In, if glaucoma is present the increase of intraocular pressure may aggravate the impairment of blood supply and cause further loss of visual field and acuity. The iris may prolapse through the incision if the intraocular pressure is more. General anesthesia using Laryngeal mask airway remains an alternative to conventional endotracheal intubation in elective ophthalmic procedures in children. There are many reports regarding its efficiency in not raising the pressor response, and not raising intraocular pressure, as it does not involve laryngoscopy and direct tracheal stimulation. Hence it is useful for children undergoing ophthalmic surgery, with raised intraocular pressure. Many studies suggest that the use of laryngeal mask airway anesthesia has less rise in intraocular pressure, blood pressure and heart rate in adults ophthalmic procedures but few such studies are done in paediatric patients.

Hence this study is under taken to compare the effects of laryngeal mask air way anesthesia with endotracheal tube intubation on intraocular pressure and pressor response in ASA I & II Grade paediatric patients undergoing elective ophthalmic procedures.

INTRAOCULAR PRESSURE

The normal intraocular pressure ranges between 10 to 20 mmHg and remains stable from 2 to 12 years of age. The anaesthetic implications of IOP in ophthalmic surgery is that since many anaesthetic drugs and the anaesthetic techniques influences IOP, in patients with existing raised IOP coming for either corrective procedures or non-ophthalmic procedures or with penetrating eye injuries, a further raise in IOP will result in a catastrophe. Acute raise in IOP may lead to globe expulsion or retinal artery occlusion and retinal ischaemia. Chronic raise in IOP leads to optic nerve compression and visual loss.

Physiology of Intraocular pressure:

Normal regulation of IOP is mainly done by aqueous humor in the anterior chamber of the eye whereas the vitreous humor in the posterior chamber will not take place in IOP regulation. Since orbital globe is a rigid noncompliant sphere, change in the volume of the contents or the external pressure will have an influence on IOP.

Aqueous humour is produced by the coliary body. Its main function is to supply the oxygen and glucose to avascular lens. It is mainly produced by active secretion NaKATPase and insignificantly through ultrafiltration of plasma which depends on the plasma oncotic pressure, blood pressure within the ciliary body and IOP. Major absorption is through trabecular meshwork and canal of Schlemm in the angle of cornea and iris to the episcleral veins. This is dependent on the pressure gradient between IOP and episcleral veins. About 20% absorbtion happens through uveoscleral route which depends on the pressure gradient between anterior chamber and the interstitium of sclera. This implies that since the production of aqueous is constant, a raise in IOP is compensated to some extent by the drainage of aqueous humour.

A change in the blood volume in the eye would change the IOP.The chief blood supply are from retinal artery and the choroidal artery. The factors which affect this blood volume are similar to that which affects the cerebral blood volume. Since the choroidal blood vessels do not have myogenic control,only the retinal arteries will dilate if the blood pressure increases. The choroidal vessels will respond to the pressure gradient. Vasodilatation occurs due to hypoxemia, hypercarbia and increased metabolic rate. The normal venous pressure inside the globe is about 15mmHg. If the pressure in the episcleral veins increases, the pressure gradient in the choroidal plexus falls leading to increased blood volume within the globe, hence the IOP increases.

Factors Regulating the Intraocular Pressure:

1. Neuro pharmacological influences -

    A. Parasympathetic stimulation or topical application of acetylcholine produces constriction of the coliary muscle, which facilitates the outflow of aqueous.

    B. Topical application of sympathomimitic agents and beta-blocker associated with decrease in aqueous production.

2. Adreno-cortical steroids: Intraocular pressure is linked to the circardial rhythm. It reaches peak in the early morning and tapers to trough in the late afternoon. Exogenous steroids applied as eye drops decreases the drainage of the aqueous. Systemic steroids are less likely to produce this response.

3. Vascular factor -

A. Increase in the blood pressure produces a transient increase in the intraocular pressure and hypotension produces a decrease in intraocular pressure.[15]

B. Increase in central venous pressure is accompanied by an increase i n intraocular pressure and this is obvious in the fluctuation of intraocular pressure with inspiration and expiration.

4. Mechanical factor: The globe is constantly subjected to non-vascular mechanical influence, which causes transient fluctuations in intraocular pressure. During eye eye movements the pull of the extra-ocular muscles on the sclera causes variations in intraocular pressure.[16]. A similar effect is produced when the eyelids are closely tightly, although this effect may be enhanced by the associated contraction of the superior rectus muscle.

Effect of Barometric pressure:

Hyperbaric oxygen, oxygen therapy at higher atmospheric pres-
sues, are associated with profound choroidal vasoconstriction and reduction in intraocular pressure.

Effect of Hypothermia:

Despite increasing aqueous viscosity, may induce significant reduction in intraocular pressure due to decrease aqueous production and associated with vasoconstriction.[17] Even, change in body position from vertical to horizontal can also cause small transient alteration.[18]

Extraglobal factors:

Anesthetic blocks like peribulbar block may raise the IOP, but the sub-tenon's block reduces the muscle tone hence the IOP.

Ocular compression device like Honan ball is used to spread the local anaesthetic after the block, reduce the chemosis, bleeding and lid swelling. It may reduce IOP.

Measurements of Intraocular pressure and Tonometry types:

Intraocular pressure can be measured broadly by two methods:

1. Direct method – Manometry

2. Indirect method – Tonometry

Manometry involves insertion of a needle directly into either anterior chamber or vitreous, which is connected to mercury or water manometry, which gives the IOP. But it is not practiced now as it is an invasive procedure, requiring general anesthesia and blood-aqueous barrier breach. It is the only method to monitor IOP continuously for experimental purposes.

Tonometry is a method of measuring IOP indirectly using a special instrument called Tonometer. It can be generally classified into

1. Indentation tonometer
2. Applanation tonometer.

SCHIOTZ TONOMETRY

The currently used indentation tonometry is Schiotz tonometer, devised by Schiotz in 1905. It is the most commonly and widely used tonometer worldwide due to its low price, simplicity, reliability and relative accuracy. In the institute of Ophthalmology where this study was conducted, Schiotz tonometer is commonly used inside the operating theatre to measure the IOP.

The working principle is that, when it is placed on the cornea, it produces indentation of the cornea. Based on several factors like the weight of the tonometer, area of the cornea indented and volume displaced, a tensile force is set up on the corneal surface opposing the weight. This force is added to the baseline IOP, which shows the new IOP. The scale reading this tension is the artificially raised IOP.

Fridenwald, developed a conversion table to convert to baseline IOP. It is called Fidenwald nomogram, if the readings are plotted in a semilog scale. The nomogram shows different readings corresponding to different weights and differing IOP.

The parts of a Schiotz tonometer are:

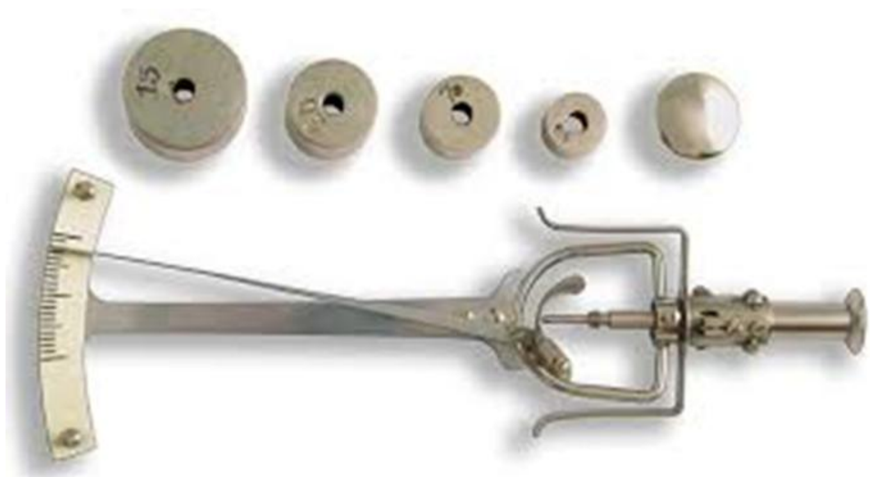
1. Handle - To hold the instrument vertically on the cornea

2. Footplate - That directly touches the cornea

3. Plunger - Moves freely on the shaft of the footplate

4. Bent lever - Which has a long arm acting as a pointer needle and a short arm resting on the plunger. The needle moves on the scale based on the amount of indentation on the cornea.

5. Weights - A basic 5.5 gms weight is always attached to the plunger. Additional weights 7.5gms or 10gms can be attached.



Technique of Schiotz tonometry:

The patient lies in supine position and fixes the eye at a target on the ceiling. The eye to be examined is anesthetized with 4% topical lignocaine. The examiner rests the footplate of the tonometer on the center of the cornea vertically, after separating the lids with the left hand. The needle moves on the scale. Once the needle becomes steady, the reading on the scale is recorded. To start with, conventionally 5.5gm weight is used. If the reading is less than 3, then additional weights 7.5gm is added and once again the reading is taken. The IOP in mmHg is then derived using the Friedenwald nomogram, based on the scale reading and the weight used.

	Plunger Load			
Scale Reading	**5.5 g**	**7.5 g**	**10 g**	**15 g**
3.0	24.4	35.8	50.6	81.8
3.5	22.4	33.0	46.9	76.2
4.0	20.6	30.4	43.4	71.0
4.5	18.9	28.0	40.2	66.2
5.0	17.3	25.8	37.2	61.8
5.5	15.9	23.8	34.4	57.6
6.0	14.6	21.9	31.8	53.6
6.5	13.4	20.1	29.4	49.9
7.0	12.2	18.5	27.2	46.5
7.5	11.2	17.0	25.1	43.2
8.0	10.2	15.6	23.1	40.2
8.5	9.4	14.3	21.3	38.1
9.0	8.5	13.1	19.6	34.6
9.5	7.8	12.0	18.0	32.0
10.0	7.1	10.9	16.5	29.6

2. Goldmann applantor: A most popular and accurate tonometer. It consists of a double prism mounted upon a slit lamp. The prism applanates the cornea of area 3.06mm diameter. With the contact of the instrument, the cornea flattens and appear as a ring of tears, fluid surrounding the flattened area. The pressure is calculated by the given formula.

3.Perkins applanation tonometer: It uses the same biprism as in the Goldman applanation tonometer but is hand held. It is portable and does not require a slit-lamp.

4. Pulse air tonometer: It is a hand held non-contact tonometer can be used in a patient with any position.

5. I-care tonometer: A light probe makes a momentary contact with the cornea and measures the IOP. It is routinely used to measure the IOP in children in the outpatient department at the institute. It requires no topical drops, it is painless and requires no special skill. The only requirement is the upright position of the head of the patient, as it cannot be done in supine position.


icare


icare

6. Tonopen: It is a computerised pocket tonometer. It is battery operated and is a hand held portable instrument. It has a microscopic transducer which applanates the the cornea and converts the intraocular pressure into a wave form which is analysed by a microprocessor and stored for statistical comparison and calculates to give a digital IOP. The tip is covered by a latex cover which is disposable and applied vertically and gently on the cornea which is anesthetized until an audible click is heard. This instrument is used in the government Ophthalmic hospital to measure the IOP in children in the OPD.

Methods to reduce IOP:

There are many pharmacological methods to reduce raised IOP. During intraoperative period, if there is sudden raise in IOP, drugs like acetazolamide or mannitol can be rapidly infused intravenously. Additional methods like head up til and hypocapnia will also help to reduce IOP.

Methods to Avoid Raise in IOP:

Among the several factors which is expected to raise the IOP, the chief factor is Episcleral venous pressure. It is directly related to CVP. Hence, Increased central venous pressure increases IOP. Trendelenberg position increases IOP, hence reverse Trendelenberg position is preferred.

Coughing, vomiting and straining increases IOP 30 to 40 mmHg. Avoiding these will help reduce IOP.

A raise in IOP of 10 to 20mmHg happens during laryngoscopy and intubation. Blunting stress response with drugs like lignocaine, clonidine, opioids and b-blockers will reduce IOP. Alternatively use of LMA instead of Endotracheal tube also reduce intubation response induced IOP raise.

In prone and lateral decubitus position, there is an increased risk of visual loss following inadvertent compression leading to ichaemic optic neuropathy. Ischaemic optic neuropathy may be due to hypotension or raise in IOP due to venous engorgement. Hence proper padding of eyes in prone and lateral position .

ANESTHESIA AND INTRAOCULAR PRESSURE

The venous pressure, blood pressure, ventilation, laryngoscopy,intubation, e xternal pressure on the eye ball, general anesthetics and many drugs used during the anesthesia have a definite influence on the intraocular pressure.

Effect of ventilation:

Hypoventilation or airway obstruction causing hypercarbia dilates choroidal arterioles, resulting in increase intraocular pressure. Hypoxia may also contribute to increased intraocular pressure through vasodilatation of intra-ocular vessels. Hyperventilation (hypocapnia) tends to lower the intraocular pressure[19] conclude that acute changes in intraocular pressure are mainly brought by haemodynamic changes. An increase in CO2 tension raises and, a decrease lowers the intraocular pressure. Useful reduction of intraocular pressure in clinical anesthesia can be obtained by maintaining pulmonary ventilation at normal or above normal levels.

Laryngoscopy and Intubation:

Endotracheal intubation is a potent stimulation for increase in intraocular pressure. Changes in intraocular pressure after endotracheal tion, produced by suxamethonium and that the changes could be attenuated by adequate topical laryngeal anaesthesia.[20]. Intubation with pancuronium does not change the intraocular pressure. External pressure from facemask, fingers, orbital tumors, contraction of the orbicularis oculi muscle or retro bulbar haemorrhage will increase the intraocular pressure.

Pharmacological Influence on Intraocular Pressure:

The intraocular pressure is influenced by many drugs may be given in the perioperative period. They act directly on the eye to induce changes in the aqueous or intraocular blood volume. They may act locally by altering the tone of the extra ocular muscles and thus alter the external compression of the sclera. They also act by depressing the central nervous system, reducing the venous and the arterial pressure, and improving the drainage of aqueous humour.

Premedication drugs like Atropine, Glycopyrrolate do not have any influence on IOP when given intravenously; but when applied topically into the eye it results in a raise in IOP by producing mydriasis.

When Glycopyrrolate or Atropine used along with Neostigmine to reverse the neuromuscular blockade will not produce any effect on IOP. They are not associated with intraocular tension even in glaucoma. Glycopyrrolate offers a better margin of safety by preventing its passage into the central nervous system. Intravenous Midazolam and Diazepam lowers IOP but equal oral doses of these donot have any effect.

Intravenous induction agents, almost all, lowers IOP except Ketamine. They depress the central diencephalic control of IOP and enhance the drainage of aqueous humour. Inducing dose of Barbiturates and Propofol reduces IOP significantly. Ketamine given both IV or IM,raises intraocular tension.But recent studies shows, Ketamine when administered after diazepam or meperidine doesnot raise IOP.

Inhalational anesthestic agents also lowers IOP in the presence of controlled ventillation and normocapnia. Nearly 14% to 50% fall in IOP is seen with

Volatiles. There is a 12% fall in IOP in neuroleptanesthesia with droperidol and fentanyl.

Depolarising muscle relaxant, Succinylcholine raises IOP transiently to about 10 to 20mmhg for 4 to 6 minutes. Nondepolarising muscle relaxants donot have any effect on IOP.Succinylcholine increases the tonicity of extraocular mucle during fasciculation.Pretreatment with d-tubocurarine to prevent fasciculations will not prevent succinylcholine induced raised IOP.

During general anesthesia,inspite of IOP lowering effect of most anesthetic agents,the anesthetic technique involving laryngoscopy and intubation,significantly raises IOP by about 10 to 20mmHg.

The Pressor response to Laryngoscopy and endotracheal intubation has been recognized since 1951. It is a sympathetic reflex provoked by stimulation of the epi- pharynx and Laryngo pharynx. The increase in blood pressure and pulse rate are transitory. They may be hazardous in patients with hypertension, myocardial insufficiency or coronary vascular disease.

The pressor response is reflex in nature. It is evident from the fact that it appears immediately as stimulus is applied. The work of Tomori and Widdi combe has shown that it results in activation of the sympatho-adrenal system. The major influences on short-term cardiovascular regulation are, autonomous nervous system and hormonal influences, capable of response within brief intervals of time. The most prominent visceral reflexes involved in the autonomic control of the heart and blood vessels are the baroreceptor reflexes, cardiopulmonary reflexes and chemoreceptor reflexes.

The vagus nerve though predominantly parasympathetic, it supplies the larynx by its branches- superior and recurrent laryngeal nerves. The Glossopharyngeal nerve supplies the superior aspect of the epiglottis, posterior 1/3rd of the tongue and lower pharynx. The intense stimulation produced by layngoscopy and intubation may cause the impulses to spread to the sympathetic, which contains some cardio-accelerator fibers. The efferent limb of the reflex is finally through the sympatho-adrenaline system. Monosynaptic pathways for motor laryngeal reflexes also exist. High concentration of opiate receptors found in the nucleus of tractus solitaries and in the nuclei of the IX and X cranial nerves, associated with the visceral afferent fibers of nerve, which originate in pharynx and larynx.

Cardiovascular system reflexly modifies to ensue adequate supply of oxygen and also remove the metabolites. The vascular smooth muscle contraction can be modified by physical, chemical or autonomic neuronal influences. Though there are no flow sensitive detectors, a group of special cells, are located at arch of aorta and carotid artery- are sensors of arterial pressure and the PH of the blood. They are carotid body and aortic body.

The cardiovascular reflexes are complexes interaction between neuronal reflex mechanisms and the metabolic auto regulatory mechanism.

There are two control systems:

1. Controls arterial pressure (quick, short lived, mediated by reflexes)

2. Controls blood volume (slow system, based on kidney)

1. Acute regulatory mechanism: A neuronal mechanism consists four components

a) Proprioceptive vascular sensors- baroreceptors

b) Chemoreceptors

c) Central nervous connections and integration of neural control

d) Efferent connections.

The most important cardiac reflexes are:

1) Baroreceptor reflex:

2) Chemoreceptor reflex

Baroreceptor reflex: Baroreceptor is special cells, which senses the change in arterial pressure. There are two types.

1. High-pressure receptors - Located bilaterally in carotid sinuses (mechano-receptors) and aortic arch (stretch receptors).

2. Low pressure receptors - Located within atria and Atrio-caval junction, which respond to change in volumes.

The afferent fibers from carotid sinus are located in Glossophayngeal nerve while those from aortic sinus, in aortic depressor nerve, a branch from vagus. These fibers relay at nucleus tract solitarius, which has influence on nucleus ambigus. The impulses reaching here have inhibitory action (Negative feedback mechanism) These receptors are stimulated when there is rise in blood pressure and increased end diastolic volume give rise to depressor reflex, resulting in decrease in heart rate, decrease in force of cardiac contraction, a decrease in peripheral vascular resistance. Activation of cardiac vagus nerve and to lesser extent by inhibition of sympathetic nerves brings in, this response.

Chemoreceptor reflex: The receptors in the carotid body and aortic body are chemosensitive cells. They respond to change in oxygen tension (<50mm Hg), and acidosis. The impulses are carried along the Glossopharyngeal nerve and vagus nerve to the chemosensitive area of the medulla. This area responds by stimulating respiratory center and parasympathetic activity. This reflex Causes increase respiration and bradycardia.

Baroreceptor & Chemoreceptor pathway:

The nucleus solitarius is the highest center to receive the impulses from aortic body, carotid body, carotid sinus and aortic sinus. The impulses originate from pharynx; larynx, upper airways, lungs as well as gustatory afferents are conducted by fibers located along Glossopharyngeal nerve, and vagus nerve to reach the nucleus solitarius. The efferents from which influence the ventrolateral medulla. The impulses from this influence the sympathetic and parasympathetic system, phrenic motor nerve and lateral reticular nucleus to initiate cardiovascular pressor and depressor response. Anaesthetic influence on baroreflex and chemo reflex of cardiovascular function:

Baroreflex induced circulatory responses are inhibited by the anesthetics for both pressor and depressor limbs of the Baroreceptor reflex.

Anesthetic agents could inhibit -

A) The receptors,

B) The afferent nerve fibers to the CNS

C) CNS sites for integration and regulation of central effector neurons

D) The efferent nerve pathways including ganglionic transmission

E) Neuro-effector junctions

Hormonal response: Many studies have indicated that the procedure of laryngoscopy can induce release of ‘stress’ harmones. The serum levels of harmones like adrenaline Noradrenaline, ACTH, ADH, are increased during laryngoscopy and endotracheal intubation. This could be one the cause of pressor response during laryngoscopy. This response is due to activation of hypothalamo-pitutory axis and also termed as sympatho-adrenal response.

ANAESTHESIA FOR OPHTHALMIC SURGERY IN CHIDREN

Almost always general anesthesia is required for children who undergo ophthalmic procedures because they do not co-operate for local anesthetic blocks. Maintaining airway under sedation is compromised, hence sedation or total intravenous anesthesia is avoided in chidren.

The common elective eye procedures for which chidren come to the hospital are

1. Examination under anesthesia
2. Measurement of IOP
3. Syringing and probing of lacrymal ducts
4. Strabismus surgery
5. Cataract extraction

Other procedures include glaucoma correction, keratoplasty, vitreretinal surgery. Among the emergency procedures, penetrating eye injuries constitute the major cause.

Preoperatively, the chidren coming for eye surgeries should be assessed for any associated illness which pose challenge to the anesthetist .and optimized before the procedure. These children has poor vision hence should be handled with care.

Premedication, can be oral or intramuscular or intravenous depending on the procedure and the anesthetist choice. It should definitely include an antiemetic, because, as such, the ophthalmic procedures are associated with increased risk of PONV and PONV raises IOP, may produce wound dehiscence and prevent healing. .Induction can be either intravenous or inhalational.

Airway equipment used in paediatric eye surgeries varies according to the procedure.

In EUA,spontaneous ventilation through LMA is usually preferred.

Since intubation increases IOP, spontaneous ventilation is maintained through facemask or LMA for children coming for IOP measurement.

LMA is used as airway device in many eye surgery as controlled ventilation can be possible. Since there is no need for laryngoscopy during LMA insertion, there is no effect on IOP. It is also associated with less coughing or straining during emergence.

Since there is limited access to the airway during surgery, whatever the airway equipment used- endotracheal tube or laryngeal mask airway, it should be safely secured and fixed in position.

Apart from conventional ETT and LMA used in young children, neonates are managed better with south facing RAE tube.

Maintainance of anesthesia is done usually with oxygen –nitrous mixture with a volatile, preferably isoflurane or sevoflurane. Halothane is avoided due to increased risk of arrhythmias especially in the presence of topical adrenalin is used.

Nitrous oxide is used with caution in eye surgeries for two reasons- one, it produces PONV and two, it increases the size of the gas bubble made of sulphur hexafluoride used in vitreoretinal surgery to tamponade retinal detachment. This expansion of the gas bubble increases IOP which results in ischaemic changes.This becomes more evident if nitrous oxide is used from the midst of the procedure rather than if used from the beginning of the procedure. If used before the start of the procedure, nitrous diffuses out of the bubble by the end of the procedure, leading to the shrinkage of bubble and leads to retinal re-detachment.

Influence of anesthetic drugs and anesthetic technique on IOP is discussed in detail under the topic anesthesia and IOP.

Oculocardiac reflex(OCR) is commonly seen during eye surgery especially in children undergoing strabismus surgery. It is seen in 60% of children.

The reflex manifests as bradycardia on traction of extraocular muscles predominantly when medial rectus muscle is pulled than the lateral rectus muscle during strabismus surgery. It can also present when there is pressure on the eye by the face mask during premedication.

The afferent limb of this reflex arc is through trigeminal nerve to the sensory nucleus in the brain and efferent limb of the reflex, through the vagus nerve to the cardiac muscle. Apart from bradycardia, atrioventricular block, junctional rhythms, atrial and ventricular ectopics and even cardiac arrest can also occur.Hence it is essential to monitor ECG continuously in children undergoing strabismus surgery.

Hypercarbia increases the risk of OCR, hence controlled ventilation is preferred to maintain normocarbia. The incidence of OCR is more in inadequate plane of anesthesia, hence depth of anesthesia should be maintained adequately.

Halothane increases the OCR whereas sevoflurane has less incidence of OCR.

The reflex bradycardia resolves immediately without any intervention once the surgical stimulus is removed. The reflex also fades on repeated stimuli and disappears automatically.

Prevention of OCR is done by giving intravenous atropine 20mcg/kg or Glycopyrrolate 10mcg/kg at the time of induction. The reflex can be attenuated by peribulbar block which blocks the afferent limb of the arc or by applying topical anesthetic drugs. Since OCR is usually associated with PONV, an antiemetic should always be given to the patients with premedication.

Extubation should be smooth without any coughing or bucking on the tube for any intraocular surgery. Extubation in deep plane is one of the method commonly practiced. Another alternative is the use of LMA which has less incidence of coughing or bucking during emergence.

Post operative analgesia requirement following ophthalmic procedure is minimal as most procedures have only mild to moderate pain, which can be managed by paracetamol orally or rectally and topical local anesthetic drops. Strabismus and vitreoretinal surgery produces more postoperative pain which require more analgesic,which can be done paractamol, a NSAID, or with intravenous fentanyl or tramadol. Multimodal analgesia should be continued into the postoperative period.

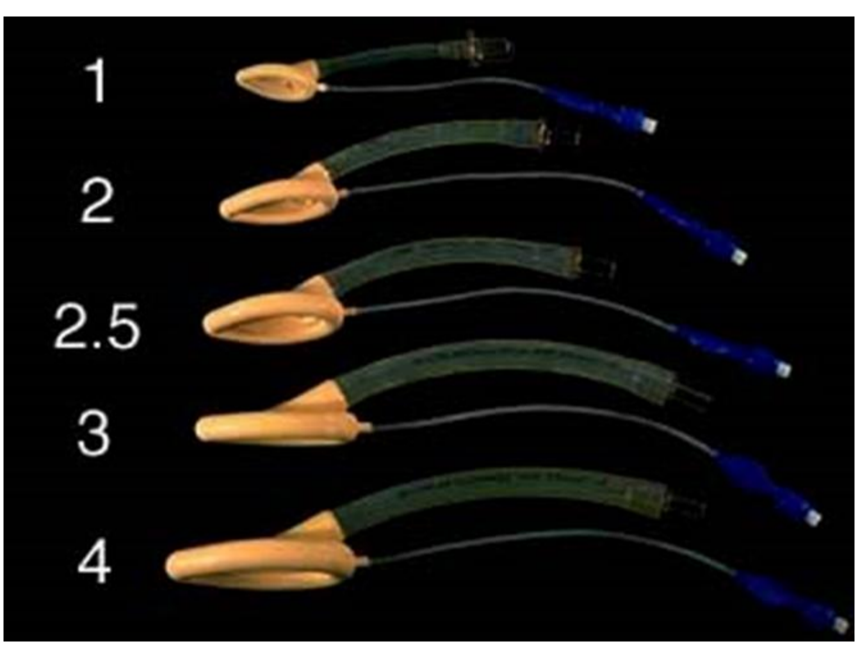
Postoperative nausea and vomiting is another common distressing postoperative complication in paediatric eye surgeries especially after a squint surgery. Intravenous ondensetron 0.15mg/kg, either alone or in combination with decadron 0.1mg/kg,when given preoperatively reduces the PONV.

Most of the children resume oral feeds at the earliest, since many eye surgeries are daycare procedures and discharged home earlier.

LMA IN PAEDIATRIC SURGERY

CLASSIC LMA

The Laryngeal Mask Airway (LMA, LMA Company, Henley, England) was conceived and designed by Dr. Archie Brain as an alternative to endotracheal tube or face-mask for either spontaneous breathing or positive pressure ventilation. Even though it was released for clinical use in 1988, FDA approval was given in 1991 only.



The LMA is a minimally intrusive device for management of airway in unconscious patients. LMA is made of medical grade silicone and does not contain any latex. Sterilisation by autoclaving and reuse can be done up to forty times. It consists of an inflatable mask fitted with a tube that exits through the mouth to permit ventilation. The mask fits against the tissues of the periglottic region and occupies the hypopharyngeal space. It forms a seal above the glottis rather than within the trachea. The aperture bars prevent the epiglottis from obstructing the airway tube.

The indications for usage of the LMA have expanded as follows,

1) An alternative to face mask for administering anaesthesia.

2) An alternative to the endotracheal tube in short procedures where intubation is not necessary.

3) A rescue device for failed intubation and “Cannot Ventilate Cannot Intubate” situations

4) An accepted alternative to endotracheal tube in management of cardiac arrest patients for securing the airway.

5) For airway management in the prehospital setting, by paramedical as well as by medical personnel.

6) As a conduit for endotracheal tube, especially when direct laryngoscopy is not successful

Contraindications include

1) Restriction of mouth opening

2) Obstruction of the upper airway

3) High risk of regurgitation and aspiration.

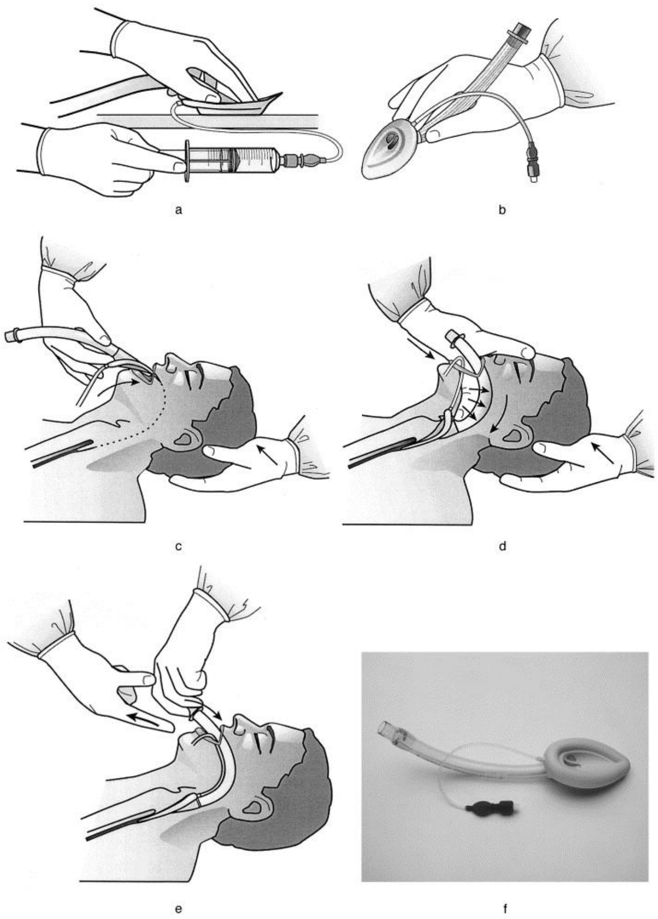
4) Abnormalities in supraglottic anatomy, either known or suspected

5) Requirement of higher airway pressures for ventilation(>20 cm of H_2O), as in case of COPD.

INSERTION:

Pre-insertion checking of the device is essential. A variety of insertion techniques have been described. Some of them are:

1) STANDARD INSERTION TECHNIQUE:



The patient is positioned as for regular laryngoscopy, with neck flexion and head extension. The cuff is deflated fully and posterior part is lubricated with water based gel. The device is held like a pen, index finger is at the point where the mask joins the tube. After opening the mouth, insertion is done along the midline with the help of the longitudinal black line on the LMA, with the device pressing on the hard palate. The index finger moves in a cranioposterior direction. Resistance is felt on reaching the upper oesophageal sphincter. The non dominant hand helps in widening the craniopharyngeal angle to aid insertion and during removal of the index finger from the mouth. The mask is inflated via the pilot balloonto a pressure not more than 60cmH_2O. A bite block is inserted and should remain in place until the LMA is removed, inorder to reduce the possibility of biting and obstruction of the airway or damage to the tube.

2) 180^0 INSERTION TECHNIQUE

The LMA is held so that the laryngeal aperture faces cephalad and then inserted. 180 degree rotation is done when reaching the pharynx.

3) PARTIALLY INFLATED MASK TECHNIQUE

Instead of fully deflating the mask, a partially inflated mask is used and this technique is found to be more successful than with a fully deflated cuff.

Size	Bodyweight	Maximum inflation volume
1	≤ 5kg	4ml
1.5	5-10kg	7ml
2	10-20kg	10ml
2.5	20-30kg	14ml
3	30-45kg	20ml
4	Small adults	30ml
5	Normal adults	40ml
6	Large adults	50ml

Confirmation of placement is by:

- Manually ventilating the patient and looking for chest movement, observing airway pressure
- During expiration, the reservoir bag refills
- Square wave capnographic tracing
- Auscultating over the neck
- Measurement of cuff -leak pressure
- Expiratory tidal volume and flow-volume loops
- Flexible fiberoptic laryngoscopy and view

The complications include

- Laryngospasm, bronchospasm
- Trauma to the airway
- Regurgitation and aspiration
- Incorrect placement including folding over of the tip, can lead to inadequate ventilation and, pulmonary oedema
- Malfunction of cuff

REVIEW OF LITERATURE

(1) Watcha et al published a study in 1992 about the use of LMA in children coming for IOP Measurement and compared with that of ETT Intubation. They conducted a randomized study of 41 Children to study the variation in IOP, Heart Rate and SBP to LMA insertion as well as ETT Intubation. They used a standardized steady state anesthesia technique and recorded these parameters 30 seconds after the insertion of the airway device and for every 1 minute thereafter for 5 minutes. They found that there was no significant raise in IOP, SBP, HR, in the LMA group. The final conclusion of their study was that LMA is advantageous over tracheal intubation in children undergoing IOP measurement.

(2) Watts et al published a study in 2007, It was a prospective comparative study in children to the effect of LMA insertion on IOP while under anesthesia. They compared the changes in BP, IOP and HR before and after the insertion of LMA. 66 children ranging between 4 months to 16 years of age, belonging to ASA I & II were included in the study. They found that there is no significant increase in IOP after LMA insertion with that of IOP before LMA insertion. They also found that there is no correlation between the measured IOP and the age of the child. The recommendation at the end of the study was that the measurement of IOP should carried out before insertion of LMA in children under general anesthesia.

(3) Ismail et al carried out a randomized controlled study in the year 2011, about the IOP and haemodynamic responses to the insertion of

LMA, i-gel or ETT. The study was conducted in 60 adults who were posted for elective non-ophthalmic procedures under general anaesthesia. Three groups with 20 patients in each group were allocated for the three airway devices. The parameters observed and compared are IOP, MAP, HR and perfusion index before induction and before and after airway device insertion. The results obtained from their study was that there was a rise in IOP in the i-gel group. Whereas in ETT group, the IOP increased which is more in post insertion period which exceeded the pre-induction value. When the HR & MAP were considered, there was a significant increase in these parameters for LMA & ETT groups but not for the i-gel group. The study also reported that there was a decrease in the perfusion index with the LMA & ETT groups but the insertion of i-gel did not change the perfusion index.

They concluded that among the airway devices i-gel provides better stability in patients undergoing elective ophthalmic procedure than in LMA & ETT insertion.

(4) Ziyaeifard et al performed a study in 2012 to evaluate the IOP and haemodynamic changes that occurs with LMA insertion or ETT intubation after induction with propofol & remifentanil in adult patients undergoing cataract surgery. 50 patients belonging to ASA PS I & II were randomly selected into two groups, each with 25 patients. After insertion of the airway, IOP, Systolic BP, Diastolic BP and Heart Rate was measured every minute till first 5 minutes. They found no significant difference between LMA and endotracheal tube groups in

MAP, HR, IOP upto 5 minutes of airway instrumentation. They concluded that propofol combined with remifentanil gives better conditions for insertion of LMA & ETT. They further reported that since LMA insertion is less traumatic than ETT, It is preferred to use LMA in these kind of patients.

(5) Bhardwaj et al carried out a study in 2011, to study the effect of LMA insertion on IOP in children with glaucoma, and compared that with ETT insertion. The study was performed as a prospective randomized single blind study in 30 children of ASA I & II, between the age group of 1 to 10 years, using standard inhalational general anesthesia with halothane and atracurium. After insertion of the device the IOP was measured in both eyes, 5 minutes from the time of insertion. This was compared to the IOP before insertion of the device in both the groups. The study reported that there was significant increase in IOP in the ETT group at 2 minutes and 5 minutes after insertion which returned to the baseline value within 5 minutes. There was an associated increase in the HR, SBP, DBP which returned to baseline after 4 minutes. Whereas, the IOP did not change significantly in the LMA group following its insertion. The post insertion raise in the HR, SBP, DBP in LMA group was not significant when compared with that of the values after ETT insertion. The study concludes that LMA insertion in children with glaucoma was not associated with further increase in IOP or hemodynamic response. Hence, LMA can be used as a safe alternative to ETT insertion in glaucomatous children.

(6) Bukari et al did a prospective randomized study in 50 patients in two groups. The study was for pressor response and IOP changes following insertion of LMA and endotracheal tube. Baseline and preinsertion values of heart rate, systolic blood pressure, diastolic blood pressure and intraocular pressure were recorded and repeated after one, two, and three minutes after securing airway. The study showed that there was significant rise in heart rate, systolic and diastolic blood pressure and intraocular pressure at one and two minutes after insertion of ETT group compared to LMA. It was concluded that LMA could be useful in situations where minimal changes in haemodynamic and intraocular pressure are desirable as use of laryngeal mask airway might offer some advantages as ithad minimal changes in haemodynamic and IOP.[55]

(7) Gulati et al studied 60 patients of age group of 1-12 years undergoing elective ophthalmic procedures, compared the use of LMA with that of an endotracheal tube. Changes in IOP and haemodynamic parameters, and intra-operative and post –operative complications were measured. There was no significant change in mean IOP after the insertion of LMA but, removal caused a significant increase (+ 7.6 mm of Hg) from a baseline of 13.9+ 4,3 mm of Hg. Endotracheal tube intubation increased the mean IOP significantly, during insertion (19.9 + 7.3 mm of Hg) from baseline value 13.1 + 4 mm of Hg and extubation raises to 24.6+10.4 mm of Hg which was clinically significant. Comparatively the rise in IOP was less in LMA insertion than in intubated cases. They conclude that the use of LMA is associated with less in-

crease in intraocular pressure than the use of an endotracheal tube in children.[56]

(8) Aktar et al.Studied in 40 patients to compare the haemodynamic changes induced by endotracheal intubation and extubation with laryngeal mask airway insertion and removal. He analysed heart rate, mean arterial pressure changes, they noted a rise in heart rate and mean arterial pressure during the insertion of endotracheal tube. (P< 0.05) it was concluded that LMA insertion & removal is associated with les cardiovascular changes compared to the tracheal intubation. Hence they recommend the use of LMA, where the pressor response is detrimental.[49]

(9) Gahi B Conducted study in 50 adult cases. The cardiovascular response and IOP was raised in both LMA & ETT pts. But the mean maximum increase was statistically more in intubated patient than with LMA & the duration of statistically significant pressure responses was also longer after endotracheal intubation. Hence it was concluded laryngeal mask airway is an acceptable alternative technique for ocular surgeries, offering advantages in terms of intraocular pressure and cardiovascular stability compared to tracheal intubation.[51]

(10) Mriduala et al have investigated the advantages of LMA over endotracheal tube on IOP and haemodynamic parameters in a randomized, parallel group study in 60 paediatric patients aged 1-12 years, in various non-ophthalmic surgeries. A standard anesthetic technique using oxygen, nitrous oxide, halothane and non0depolarising muscle relaxant was used in all the patients. There was a statistically significant increase in haemodynamic parameters and IOP following endotracheal

intubation incomparison to LMA insertion[67] . They recommend the use of LMA for emergency intraocular surgery in patients with penetrating eye injuries and severe angle closure glaucoma [52]

(11) Eltzschig HK et al studied 40 patients of ASA I & II for the effect of tracheal intubation or LMA insertion on IOP in strabismus patients undergoing balanced anesthesia with sevoflurane and remifentanil. IOP heart rate, mean arterial pressure were measured, before induction, immediately after induction and after airway insertion. It was observed that IOP. Mean arterial pressure and heart rate did not differ significantly form base line values in both the groups. Hence they concluded that remifentanil, sevoflurane are not associated with an increase in IOP response during tracheal intubation or LMA Insertion.[53]

(12) Chawla et al have done a comparative study of intraocular pressure changes with laryngeal mask airway and tracheal tube. Intraocular pressure, heart rate, mean arterial pressure changes were measured in patients receiving conventional general anesthesia through an ETT, and LMA group for 5 minutes after their insertion. The immediate rise in IOP was significantly less in patients in LMA insertion (0.85+ 1.95 mmHg.) compared with ETT intubation (7.41+ 4.97). The IOP continued to be less in LMA group at all points of time. The increase in mean arterial pressures was similar and statistically significant in both the groups immediately after airway insertion. Hence the LMA can be used as substitute for ETT where the pressor response is to avoided.[42]

(13) Barcly et al performed a randomized study in 20 patients with glaucoma to examine the effects of tracheal intubation and laryngeal mask insertion on IOP, mean arterial blood pressure and heart rate, after insertion of LMA. Propofol was used as an induction agent. The IOP remained significantly below base line values in both the groups. Insertion of LMA did not raise the intraocular pressure. Tracheal tube

insertion was associated with a significant increase in intraocular pressure to above baseline values. Use of LMA had minimal effects on mean arterial blood pressure and heart rate; where as tracheal intubation significantly increased both factors relative to pre intubation.[43]

(14) Myint Y et al have analysed changes in IOP during spontaneous ventilation with LMA and with controlled ventilation using a tracheal tube in 40 patients undergoing intraocular surgery. Anaesthesia was induced with Propofol and maintained with enflurane, nitrous oxide in oxygen. The IOP was measured before induction, after establishing the airway, at the end of the operation and after removal of the airway. IOP were lower than, baseline and similar in the two groups throughout anesthesia. After removal of TT the IOP was significantly higher than the LMA group. It was suggested that spontaneous ventilation with a LMA is an acceptable alternative to controlled ventilation with tracheal intubation in elective intraocular surgery. [44]

(15) Shroff et al carried out a study involving 50 patients with ASA I&II to find out the changes in IOP and cardiovascular response to LMA and TT. All the cases were induced with thiopentone, maintained with pancuronium, N20+ 02 under controlled ventilation. The parameters like, pulse rate, BP, IOP were measured after 1 minute, 5 minutes 10 minutes and 15 minutes. The statistical analyses revealed, $P<0.05$, rise in the pulse, BP, IOP after 1 min, rise in pulse, IOP after 5 minutes and rise in pulse after 10 minutes, statistically significant in both the groups. The rise in IOP after 10 minutes was statistically significant only after the endotracheal intubation. The rise in the pulse,

BP, IOP, after 15 minutes was not statistically significant in both the groups. Hence the study show a transient and minimal advantage of the LMA over T.T. [46]

(16) M. S.Alam, et al Studied 40 cases for intraocular pressure changes, along with blood pressure & heart rate with laryngeal mask anesthesia and endotracheal intubation. They observed that in intubated patients the IOP was raised up to 21.995 mm of Hg. From the base line 15.61 mm Hg.& never reached the baseline. Where as in cases with LMA the IOP came down to 11.3 mm Hg from the base line reading 15.61 mmHg. Post-operative vomiting, cough, and sore throat were less in the LMA group than intubated cases.[47]

(17) N. Braude et al Analysed 46 healthy patients in two groups of LMA insertionand tracheal intubation. In about .80% patients of intubation had increase in systolic blood pressure immediately after tracheal intubation, and for the subsequent 2 minutes. Similarly the diastolic blood pressure and pulse rate were also elevated. They have also observed the pressor response in those who had LMA insertion. But, the less intensity and duration. It is proposed that though the insertion of LMA does not require laryngoscopy, introduction of device and inflation of the cuff stimulates and exerts pressure on the anterior pharyngeal wall. This initiates the pressor response. The transient nature of the response suggests that this is not related to the continuous pressure exerted by the sealing cuff. The intensity of stimulus is less compared to laryngoscopy and intubation. Hence they opine that, use of laryngeal mask may offer some limited advantages over tracheal intubation in

the anesthetic management of patients where the avoidance of the pressor response is of particular concern.[38]

(18) Holden et al studied, 52 patients in two groups, scheduled to undergo elective general anaesthesia for elective cataract surgery. They measured intraocular pressure, before and throughout airway establishment with either the LMA or ETT. There was significant smaller increase in IOP (P<0.001) using the LMA during placement and removal than with ETT. There was a significant rise in heart rate in ETT group without rise in blood pressure. Postoperative cough was significantly reduced in LMA group; hence they recommend LMA as an alternative to tracheal intubation in ophthalmic surgery[39]

(19) K Lamb et al assessed suitability of LMA as a substitute for tracheal intubation. The study consists of two groups of 10 patients receiving standardized anesthesia with thiopentone and Vecuronium as muscle relaxant. N20 in oxygen, enflurane were used in both the groups. IOP and systemic pressor effects –heart rate changes, catacholamines concentrations were measured at pre induction, post induction, 1 min, 2min pre extubation, post extubation 1 min and 2 min. There were significantly smaller changes in the pressor responses to insertion and concentration of catacholamines in LMA group compared to tracheal group. The observation parameters were significantly less throughout the procedure with LMA insertion compared to TT. The changes were still significant at the time of extubation. Hence they propose, LMA use is an acceptable technique for intraocular surgery.[40]

AIM OF STUDY

The aim of the study is to Compare the intraocular pressure changes and hemodynamic responses to the insertion of laryngeal mask airway and endo-tracheal tube in elective paediatric ophthalmic surgery.

The Parameters compared are:

1. Variation in intraocular pressure
2. Peak intraocular pressure
3. Variation in hemodynamic response
4. Adverse reactions

MATERIALS AND METHODS

This is a prospective randomised control study to compare and evaluate the variation in intraocular pressure and hemodynamic responses to the insertion of laryngeal mask airway and endotracheal tube in elective paediatric ophthalmic surgery.

- After obtaining Ethical committee approval, sixty paediatric patients of ASA grade I &II scheduled for elective ophthalmic surgeries under general anesthesia will be studied after obtaining informed written consent from patient's parent.
- The patients are randomly divided into two groups of 30 patients each. Group I and Group II

STUDY CENTER:

The study was conducted at Regional institute of Ophthalmology and Government ophthal Hospital, Chennai after obtaining approval from the Director of the Institute.

STUDY DESIGN:

This was a prospective randomised control study done over a period of three months. Randomisation was done by closed envelope method.We divided sixty children into two groups

- Group I – Patients subjected to LMA insertion and
- Group II – Patients subjected to conventional Laryngoscopy and endotracheal intubation

INCLUSION CRITERIA:

- ASA : I &II
- Surgery : Elective
- COPUR scale of airway assessment : 5 to 7 points
- Should have given valid informed consent.

EXCLUSION CRITERIA:

- Not satisfying inclusion criteria.
- Patients posted for emergency surgery
- Patients with predicted difficult Intubation
- Patients with increased Intraocular pressure
- Children having upper respiratory infection, cardiovascular problem, respiratory disease, neck deformities, history of convulsions
- Allergy or contraindication for any of the drug used

MATERIALS REQUIRED:

- Completely checked Anaesthesia machine
- Oxygen, suction apparatus.
- Schiotz Tonometer, Tonopen, I-care
- Airway device – appropriate size LMA, Endotracheal tube
- Intravenous fluid - ringer’s lactate
- Monitors-ECG, non-invasive blood pressure, pulse oximeter, capnogragh, precordial stethoscope

- Drugs – Emergency drugs, Inj.Glycopyrrolate, Inj.Pentazocine, Inj.Ondansetron, Inj. Propofol, Inj. Atracurium, Volatile-Isoflurane, Inj.Neostigmine

METHOD:

- After clearance from the Institutional Ethical Committee, sixty paediatric patients were enrolled for the study over a period of three months. Pre operative assessment and application of inclusion and exclusion criteria were done. Written informed consent was obtained from the parents.
- The sixty paediatric patients enrolled in the study were grouped as thirty patients each for Classic LMA and Endotracheal tube to be studied, by closed envelope method.
- Preoperative IOP were recorded with Tonopen or I-care in the OPD.
- Standard fasting protocol for paediatric patients were followed.
- When the paediatric patients were shifted inside the premedication room, venous cannula was secured and Inj. Glycopyrrolate 10 μ/kg iv., Inj. Ondansetron 0.1mg/kg iv and Inj.Pentazocine 3mg/kg iv. were given.
- Inside the Operation theatre,standard monitors like SPO2,NIBP,ECG,ETCO2were connected to the patient and baseline parameters were recorded.
- Baseline Intraocular pressure were measured in the non operating eye by the ophthalmic surgeon using Schiotz tonometer after instilling 4% topical lignocaine.

- Induction was done with Inj.Propofol 2mg/kg followed by intubating dose of muscle relaxant Inj.Atracurium 0.5mg/kg.
- Tracheal intubation or LMA placement was done 3 mins thereafter after achieving adequate depth of anesthesia which was observed by easy up and down movement of the mandible and also absence of response to bilateral jaw thrust.
- Position of patient – sniffing the morning air/ Magill's position
- Repeat IOP measurements was taken by Schiotz Tonometer 3mins after induction; 30 secs after LMA or ETT placement and again 2mins after placement of airway device.
- Classic LMA was inserted by standard finger insertion technique and Endotracheal tube was inserted using conventional Laryngoscopy.
- The controlled ventilation was maintained with oxygen and nitrous oxide mixture in the ratio of 1:1 with 0.6%Isoflurane using a Jackson Rees circuit.
- The secondary outcome measures like the systolic and diastolic BP, Mean arterial pressure, Pulse rate, respiratory rate, and oxygen saturation were monitored throughout the procedure.
- At the end of surgery, residual Neuromuscular blockade was reversed with Inj.Neostigmine and Inj.Glycopurrolate;Extubation of LMA or ETT was done after establishment of spontaneous breathing and response to verbal command. Episodes of coughing, straining and breath holding are recorded during emergence.

- Patients were observed till discharge for both intraoperative and post operative complications like laryngospasm, bronchospasm, blood staining of device, stridor, hoarseness of voice or painful phonation.

OBSERVATION AND RESULTS

STATISTICAL ANALYSIS

Data were analysed using INSTAT 3 (Graph Pad Software, California, USA). Two sided independent student' s *t* tests to analyse continuous data, Fisher's exact test and chi-square test for categorical data were used. $P<0.05$ was considered as statistically significant.

DEMOGRAPHIC DATA:

The two groups were comparable with respect to their age, weight, height and bedy mass index. There was no statistically significant difference among two groups in demographic profile.

AGE (Student's t-test):

	LMA	ETT
Mean	6.4	6.55
Standard deviation	2.475	3.474
P value	**0.8479**	

Value and Statistical Significance:

The two-tailed P value equals 0.8479

By conventional criteria, this difference is considered to be not statistically significant.

Confidence Interval:

The mean of Group One minus Group Two equals -0.15000

95% confidence interval of this difference: From -1.70887 to 1.40887

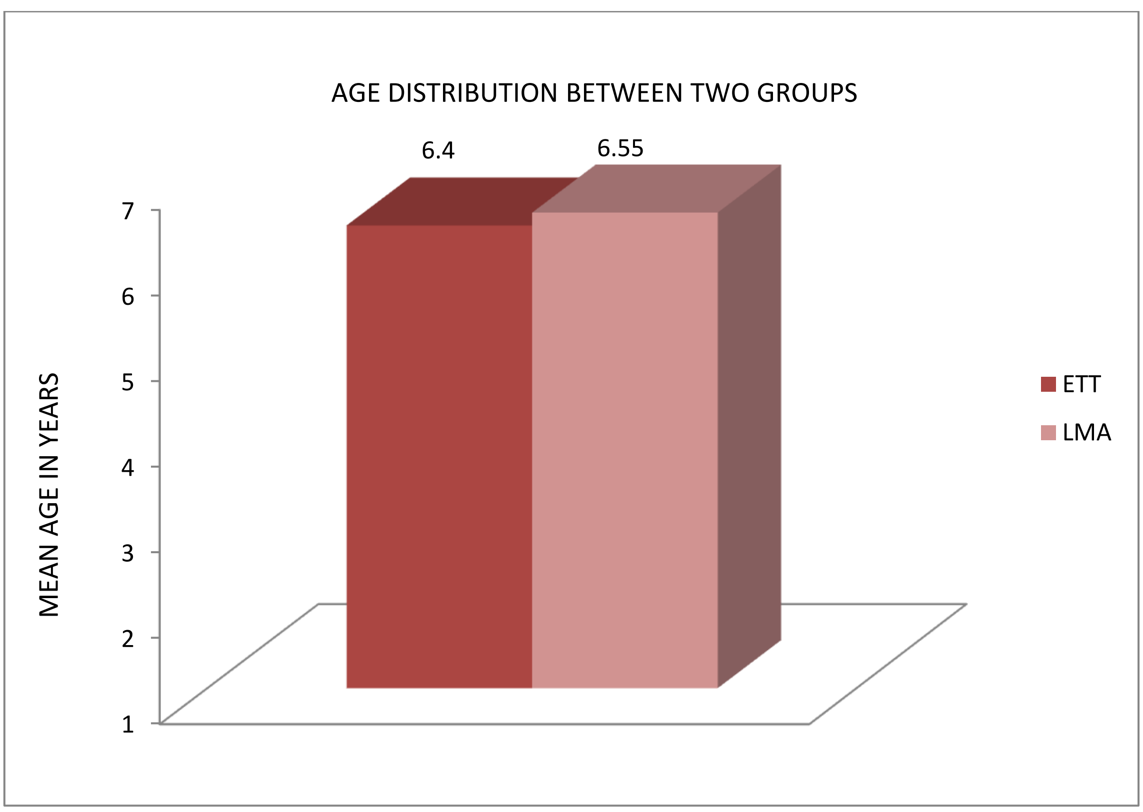
	LMA	ETT
Mean	19.36	20.53

Intermediate values used in calculations are as follows:

t = 0.1926

df = 58

Standard error of difference = 0.779



WEIGHT (student's t-test):

Standard deviation	6.835	9.7121
P value	**0.5915**	

P value and statistical significance:

The two-tailed P value equals 0.5915

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -1.170000

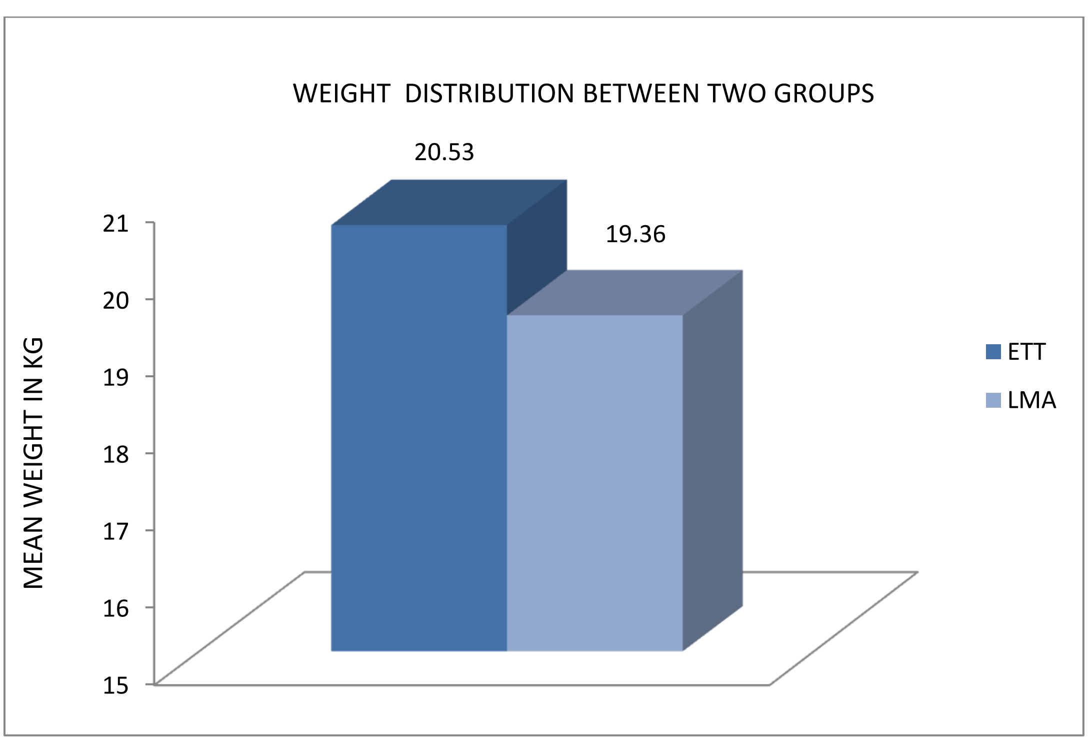
95% confidence interval of this difference: From -5.510268 to 3.170268

Intramediate values used in calculations:

t = 0.5396

df = 58

Standard error of difference = 2.168



HEIGHT(student's t-test):

P value and statistical significance:

The two-tailed P value equals 0.6480

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -2.35000

95% confidence interval of this difference: From -12.59950 to 7.89950

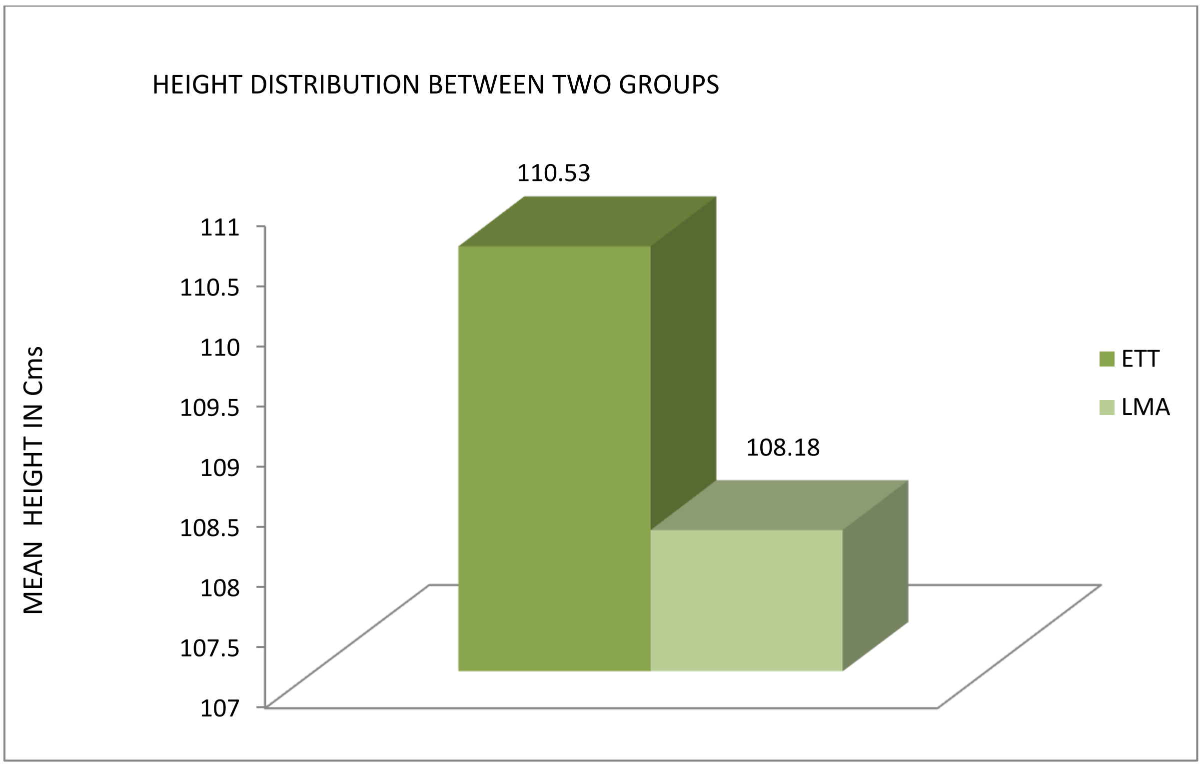
	LMA	ETT
Mean	108.18	110.53
Standard deviation	15.654	23.27
P value	0.6480	

Intromeadiate values used in calculations:

t = 0.4590

df = 58

standard error of difference = 5.120



	LMA	ETT
Mean	16.213	15.97
Standard deviation	2.689	2.636
P value	0.7250	

BODY MESS INDEX(student's t-test)

P value and statistical significance:

The two-tailed P value equals 0.7250

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals 0.24300

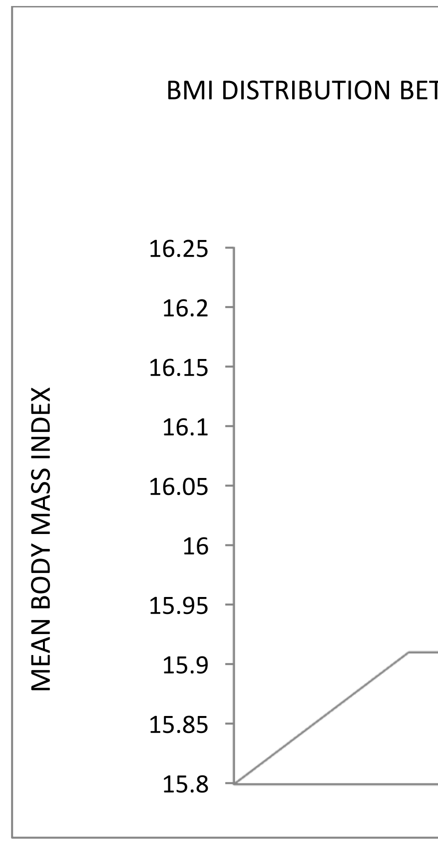
95% confidence interval of this difference: From -1.13316 to 1.61916

Intelmediat values used in calculations:

t = 0.3535

df = 58

standard error of difference = 0.687



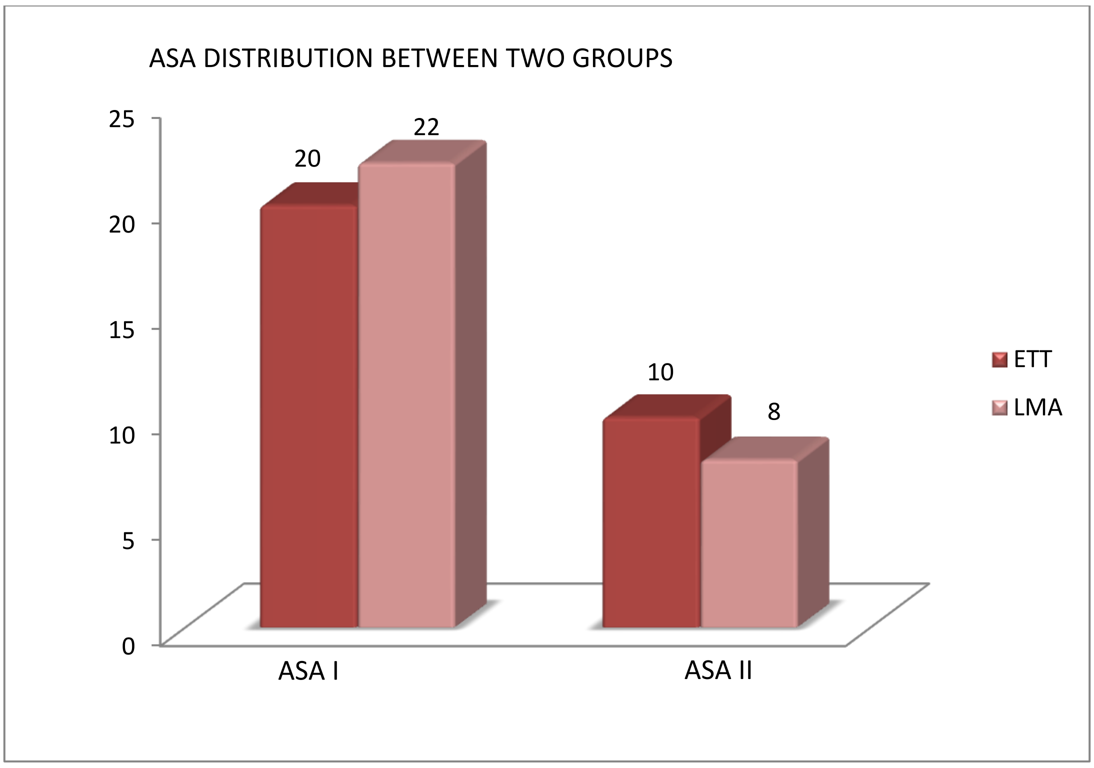
ASA (chi square test):

	LMA	ETT	P VALUE
I	22	20	0.7782
II	8	10	

Chi squared equals 0.079 with 1 degrees of freedom.

The two-tailed P value equals 0.7782

The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.



COPUR INDEX (chi square test):

	LMA	ETT	P VALUE
5	10	9	0.8948
6	12	12	
7	8	9	

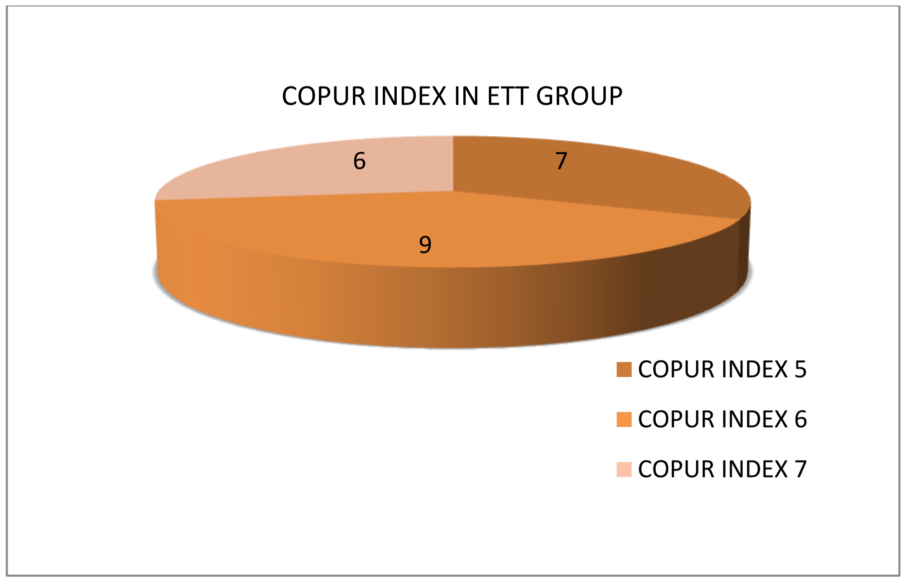
P value and statistical significance:

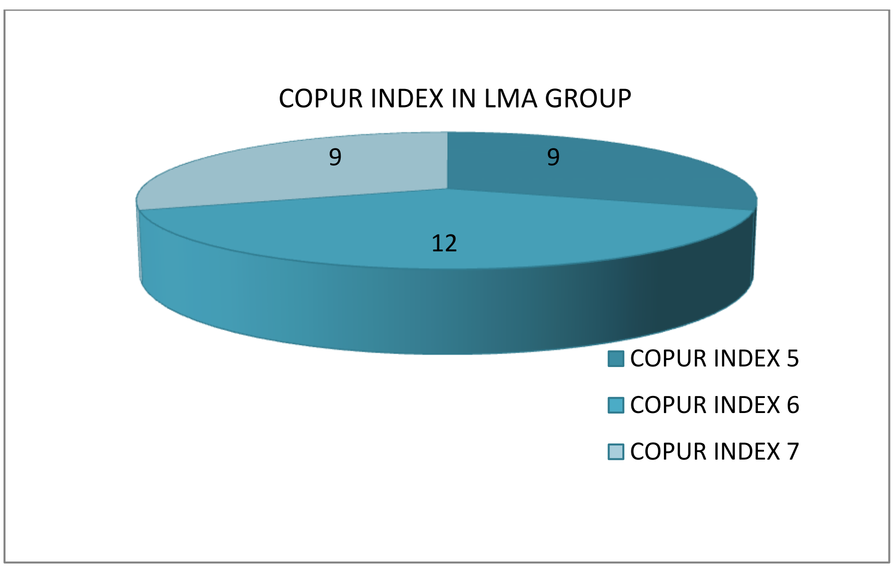
Chi squared equals 0.222 with 2 degrees of freedom.

The two-tailed P value equals 0.8948

By conventional criteria, this difference is considered to be not statistically significant.

SIZE	ETT
3.5	1
4	3
4.5	5
5	5



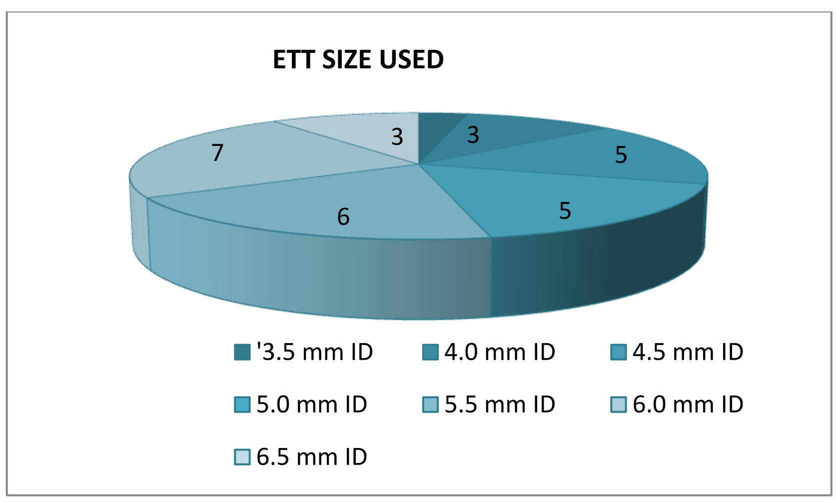


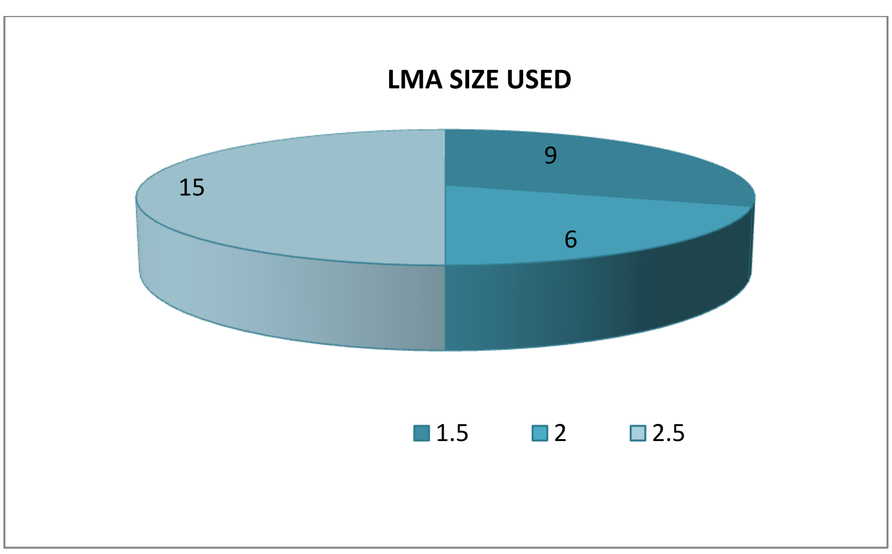
SIZE OF ETT & LMA:

5.5	6
6	7
6.5	3

	LMA	ETT	P VALUE

SIZE	LMA
1.5	9
2	15
2.5	6

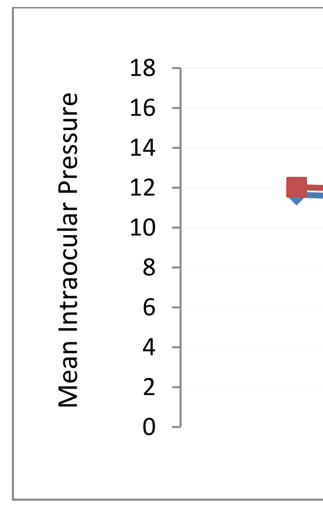




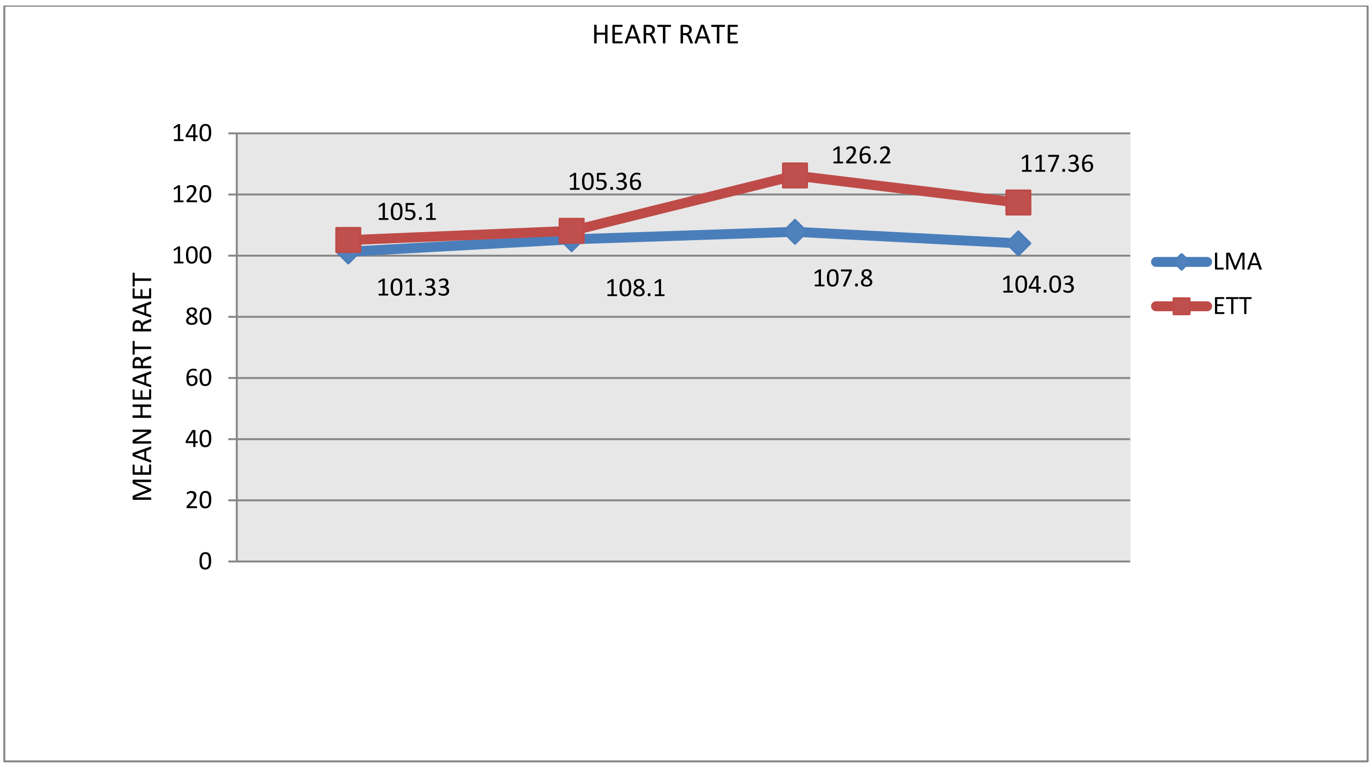
INTRAOCULAR PRESSURE (student's t-test):

BASELINE	11.65±1.419	12.03±2.23	0.4342
PREINSERTION	11.25±1.454	11.753±2.347	0.3225
30 SECONDS	11.076±1.959	15.76±2.749	0.0001
2MIN	10.57±1.6028	14.66±2.629	0.0001

	LMA	ETT	Pvalue
BASELINE	101.33±11.36	105.1±12.87	0.2339
PREINSERTION	105.36±12.22	108.1±11.795	0.3805
30 SECONDS	107.8±13.417	126.2±10.996	0.0001
2MIN	104.03±10.607	117.36±11.654	0.0001



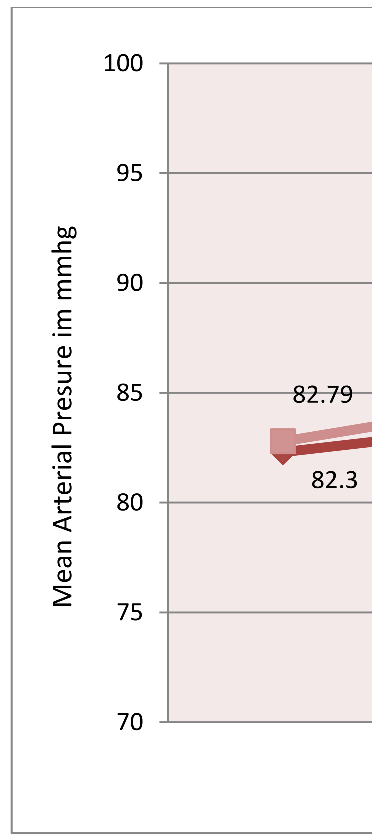
HEART RATE (Student's t-test):


HEART RATE
MEAN HEART RAET
140
120
100
80
60
40
20
0
105.1
105.36
126.2
117.36
101.33
108.1
107.8
104.03
LMA
ETT

MEAN ARTERIAL PRESURE (student's t-test):

	LMA	ETT	Pvalue
BASELINE	82.3±6.832	82.798±8.47	0.8030
PREINSERTION	83.5±4.511	84.52±9.273	0.5901
30 SECONDS	84.8±4.637	98.4±8.6	0.0001
2MIN	84.2±4.546	91.7±4.815	0.0001

	LMA	ETT	P Value
Breath holding	1	5	
Cough	1	7	



COMPLICATION (CHI SQUARE):

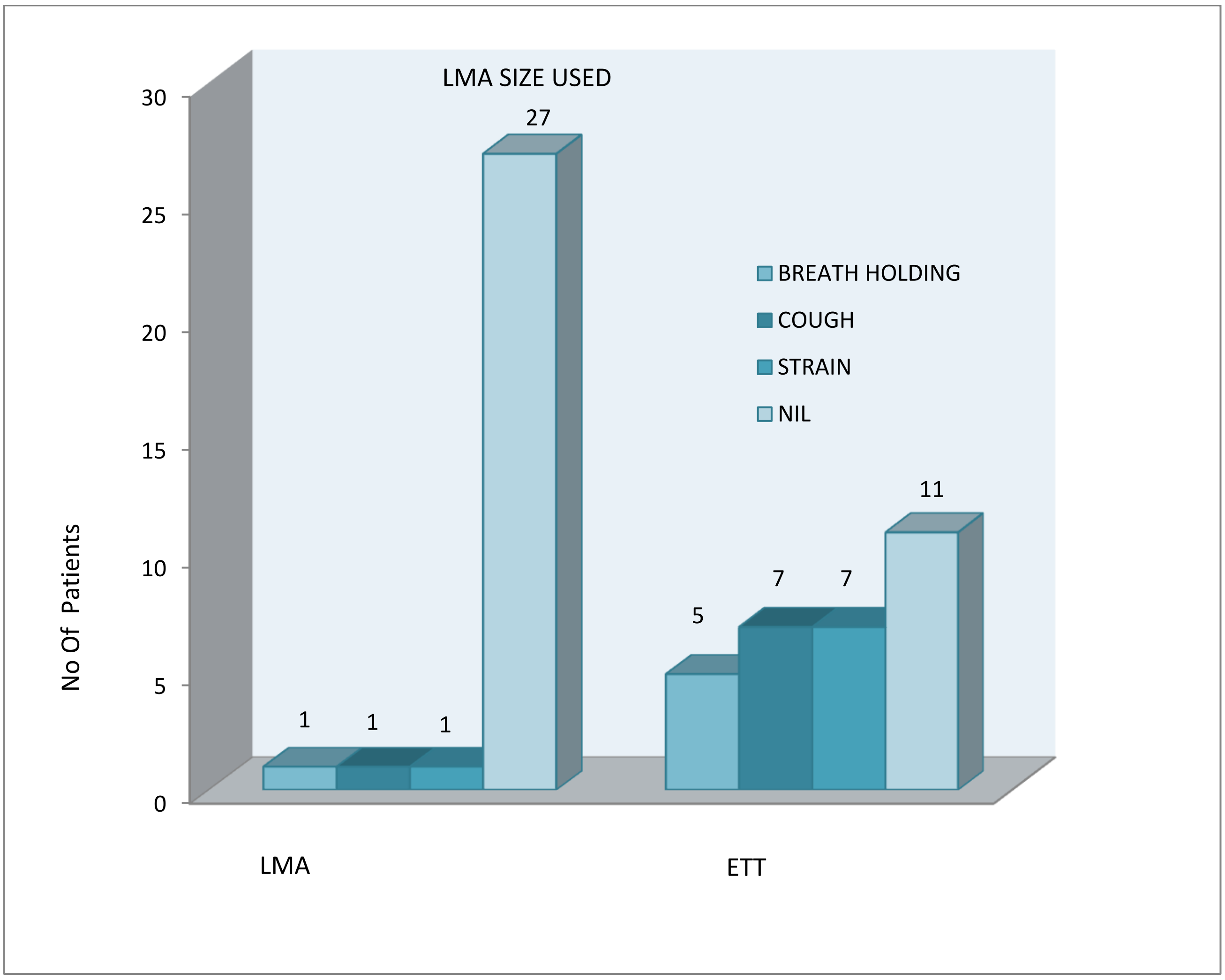
Strain	1	7	0.0001
Nil	27	11	

P value and statistical significance:

Chi squared equals 36.758 with 3 degrees of freedom.

The two-tailed P value is less than 0.0001

Row #	Category	Observed	Expected #	Expected
1	Breath holding	1	5	16.667%
2	Cough	1	7	23.333%
3	Strain	1	7	23.333%
4	Nil	27	11	36.667%



DISCUSSION

The Main anesthetic goal in Intraocular surgery is the maintenance of a stable intraocular pressure, as the sudden raise in Intraocular pressure during open eye surgery can cause prolapse of iris or lens and vitreous loss leading to permanent loss of vision. Conventional laryngoscopy with general anesthesia is usually practised in paediatric patients coming for Intraocular procedure. This causes sympathetic stimulation with resultant increase in IOP, with associated raise in MAP & HR. Today, LMA has come to be widely used as an alternative airway device during daycare anesthesia. The LMA has become a very attractive alternative to endotracheal tube.

There are few studies conducted in children to compare the effect of insertion of LMA with endotracheal intubation on IOP. But there are a number of studies done on adults, to confirm that LMA serves as an effective alternative to endotracheal intubation. Among the few studies in children, two studies were conducted in non-ophthalmic surgeries to compare the effect on IOP. One study is done in ophthalmic surgery to compare the IOP between LMA & ETT.

This is one such study to compare the effect of LMA Insertion and ETT intubation on IOP in elective paediatric ophthalmic surgery. The present study consists of 60 chidren belonging to ASA grade I & II who were randomly grouped into two groups as LMA and ETT group,with 30 chidren in each group. All patients were anesthetised as per the protocol. The parameters like IOP, heart rate, systolic and diastolic blood pressure were noted, at, before induction, after induction, and 30 seconds and 2 minutes after insertion of LMA or ETT. In the present study, comparison of IOP, heart rate, and systolic and diastolic blood pressures, in both the groups has been done.

After finding the demographic variables to be comparable, we proceeded with comparing the other variables.

INTRAOCULAR PRESSURE:

In the OPD, the pre-operative IOP was recorded in children using I-care or Tonopen as these require much less co-operation from children. The baseline IOP was recorded only after induction with 4% topical lignocaine drops applied in the non-operating eye alone.

By avoiding IOP measurement in the operative eye, inside the operating theatre, we avoid the chance of introducing any new infection into the well prepared operative eye. Since, children do not co-operate to measure the baseline IOP inside operation theatre, it is usually done after induction of anesthesia.

In LMA group the base line IOP was 11.65+1.419mm of Hg (mean+S.D). There was an initial fall in IOP to 11.25+1.414, mm of Hg (mean+S.D) immediately after induction but before insertion of LMA. There was progressively decline in IOP to 11.076+1.959 mm of Hg (mean + S.D), 10.57+1.602 mm of Hg (mean +S.D) at 30 seconds and 2 minute respectively after insertion of LMA. The fall was highly significant. $P<0.001$.

In ETT group the baseline value of IOP was 12.03+2.23 mm of Hg (mean +S.D), immediately after induction, but before intubating the trachea. Immediately after induction, but before tracheal intubation, the IOP had a fall to 11.753+2.347 mm of Hg (mean +S.D). A significant rise in IOP was observed in 30 seconds and 2nd minute with mean value of 15.76+2.749 mm of Hg (mean+S.D) and 114.66+2.629 mm of Hg (mean +S.D) respectively. There was a fall in IOP at 2nd minute. But this value was still above the baseline value. The comparison IOP between both LMA & ETT group shows that the IOP was significantly raised at 30 seconds and 2 minute of tracheal intubation ($p<0.001$), there was a highly significant fall in IOP in the LMA group at 2nd minute of LMA insertion This initial fall in IOP may be due to use of Propofol as an induction agent.

Barcly et al 43 have done similar study in 20 patients of glaucoma to find out the effects of tracheal intubation and laryngeal mask airway insertion on IOP. They have also used Propofol as an induction agent. There was an initial fall in IOP below the baseline in both the groups. Insertion of LMA did not raise IOP, but tracheal tube insertion was associated with significant raise in IOP above the baseline. Similar observations have been noted in our study.

40 patients were analysed for changes in IOP by Myint ET al44 during spontaneous ventilation with LMA and controlled ventilation using tracheal tube, undergoing intraocular surgery. They also have used Propofol as an induction agent along with enflurane, N20 in oxygen. The IOP was lower than the baseline & similar in both the groups. After extubation, the IOP was significantly higher than LMA group.

Our study was done with controlled ventilation in both the groups. The IOP values were raised after tracheal intubation and not with LMA insertion.

Our observations in the present study was almost identical with the observations of Bukhari et al 55 who did a randomized study in 50 patients of two groups for IOP changes following insertion of LMA and endotracheal tube. Thiopentone was used as an induction agent. There was significant fall of IOP below baseline after induction but before insertion in both the groups.

The IOP was significantly raised at 1 minute of insertion of ETT .In our study the IOP was raised even up to 2nd minute in ETT group.

K Lamb et al assessed suitability of LMA as a substitute for tracheal intubation. Thiopentone was used as induction agent and Vecuronium as muscle relaxant. IOP was measured at various timings during the insertion and extubation. There was a signif cantly smaller change in IOP to insertion as well as removal of LMA compared to tracheal group.4 0

In present study significant fall of IOP has been observed at variable timings after insertion of LMA where as IOP was raised in ETT group. Hence use of LMA appears beneficial in intraocular surgery.

Holden et al reported, a significant smaller increase in IOP (P<0.001) using the LMA & ETT during placement and removal compared with ETT before and throughout airway establishment in 52 patients, scheduled to undergoing cataract surgery.3 9

Shroff et al have observed that there was no significant change in IOP before or after up to 5 minutes of insertion of both LMA and ETT placement. 46 Both the observation done by Holden & Shroff differ from present study. But still they recommend the use of LMA for its other advantages.

The rise in IOP with endotracheal intubation is tolerated to some extent in normal eye, but may produce deleterious effect in patients with already raised IOP like acute angle closure glaucoma or in children with penetrating eye injury. Even a small rise in IOP for a short time in these patients, may cause optic disc ischaemia resulting in blindness in acute angle closure glaucoma. Whereas in penetrating eye injury, expulsion of intraocular contents occurs with any further rise in IOP. In chronic glaucoma the incidence of loss of central vision is about 30% when the IOP rises above 20 mmHg., whereas the incidence is less when IOP is below 18 mmHg.

In our study, the mean maximal IOP rise was less in LMA group when compared with ETT group during intubation. The variation in IOP at different time points was greater in ETT group when compared to LMA group. The hemodynamic changes correlated with changes in IOP in both the groups. In most of the cases in our study, tracheal intubation produced a raise in HR, MAP whereas LMA insertion was not associated with rise in these variables.

Thus the overall opinion on IOP changes with LMA insertion is in favor than the use of ETT

HAEMODYNAMIC CHANGES:

In the present study both Heart rate and blood pressure have been analysed for haemodynamic changes in comparison with use of LMA &ETT.

HEART RATE (H R):

In LMA group the mean value of HR was 101.33+11.36/ min (mean +S.D). & There was a declining trend throughout the procedure.In ETT group the HR was 101.5+12.87/ min and had a rising trend insubsequent timings.There fore there was is a rising trend in heart rate in ETT group compared to group LMA group. (P<0.05)

BLOOD PRESSURE (BP): In LMA group the mean baseline mean blood pressure (MAP) was 82.3+6.832 mm of Hg (mean + S.D). There was a declining trend in MAP after induction and through out the study.In ETT group, the mean baseline MAP was 82.798+8.47 mm of Hg (mean + SD). After induction and before intubation there was an initial fall in blood pressure and was raised after 30seconds of intubation but at 2nd minute there was a decline in mean value of blood pressure MAP, but the fall was not below the baseline value. (P < 0.05)

Barcly et al, K Lamb, & Bukari et al have studied haemodynamic changes along with IOP. Barcly et al 43 studied in 20 patients, where in Propofol was used as an induction agent. There was a minimal effect on mean arterial blood pressure and heart rate with use of LMA and significant rise in HR and BP with tracheal intubation. In the pr sent study has similar observation of fall in HR and BP with use of LMA and rise in the same with the use of ETT.

The study done by Bukari et al 55 reveals that, there was increase in HR immediately after insertion of LMA & ETT and remained elevated more in ETT group compared to LMA group. There was increase in blood pressure in ETT group at 30seconds of intubation. In present study throughout the heart rate & BP showed a declining trend in LMA group. ETT group had an initial fall in HR and BP after induction but before insertion. The mean value of HR & BP was elevated at 30 seconds. On the contrary the study done by K Lamb et al showed a smaller fall in changes in the pressor response and catacholamines levels in LMA group compared to ETT. In the present study measurement of catacholamines is not included. The cardiovascular responses to LMA insertion and ETT intubation studied by Wilson et al in 40 patients, showed a smaller fall in cardiovascular response in LMA group compared to Laryngoscopy and intubation.

Ameetkumar et al 50 studied cardiovascular response in 60 patients compared to insertion of LMA and ETT. The HR. BP was significantly higher in ETT group compared to LMA group. They concluded the use of LMA is safe in haemodynamically-compromised patients. A similar observation is noted in the present study

Aktar et al 4 9 compared the haemodynamic changes with LMA & ETT during insertion and removal. They noted a rise in heart rate and blood pressure in ETT group.

Same observations were seen during intubation in the present study. Thus by comparing the above studies and the present study indicate clearly that haemodynamic responses can be effectively minimized by the use of LMA.

Coughing, straining, breath- holding, rises intraocular pressure. Coughing may increase IOP uptill 50 mmHg. In our study, the incidence of coughing during emergence was high among children who were intubated with ETT rather than with LMA. Out of 30 children in ETT group, 7 children had coughing during emergence whereas in LMA group, only one child coughing. The incidence of straining was 23.33% in ETT group but only 3.33% in LMA group.

Akhter et al and Holder et al have reported high incidence of coughing and straining during emergence in tracheally intubated adult patients. Denny and co-workers have also reported similar findings in adult patients. The incidence of breathholding is higher in ETT group than in the LMA group.

Vomiting has been a distressing post-operative complication especially in children undergoing strabismus surgery. It was also suggested to be due to the use of positive pressure ventilation, and due to gastric insufflations.

In our study, it was found to be of a higher incidence in LMA group than in the ETT group. Out of the six children who had post-operative vomiting in LMA group, 3 children underwent strabismus repair.

Anesthesia for paediatric ophthalmic surgery,American journal of ophthalmology,2011, have reported a low incidence of complications in children undergoing ophthalmic surgery under LMA. In our study, two patients in the LMA group, had desaturation for a brief time due to intra-operative displacement, Improper fixation, inadequate plane of anesthesia and pressure in the LMA by the surgeon were the reasons for malposition of LMA. We Immediately repositioned the misplaced LMA, adequate depth of anesthesia is restored.

If LMA displaces, then methods to restore airway by tracheal intubation may increase the intraocular infection risk or may lead to extrusion of intraocular contents. Hence, proper fixation of the LMA, monitoring of neuromuscular blockade, and maintaining an adequate plane of anesthesia are mandatory while LMA is used for intraocular surgeries.

During extubation, we preferred to extubate both the groups in a deeper plane of anesthesia to minimize coughing, straining and laryngospasm. In our study, the incidence of laryngospasm during extubation was less in both groups as we excluded the children with upper airway infection. Children with upper airway infection were given six weeks post infection period to recover, before taking them for elective ophthalmic procedure.

The occurrence of breath-holding during emergence was higher in ETT group 16.6% but 6.6% in LMA group. This was similar to the reports observed by Akhtar and Co-workers.

In both groups, none of the children reported post-operative sore throat, probably because the children are less likely to report than adults.

The overall statistical analyses of the present study and most of the literature published reveals that there is significant rise in IOP, heart rate, systolic and diastolic blood pressure in the ETT group as compared to LMA

SUMMARY

In the present study 60 patients belonging to ASAI& II of both sexes between age group 2 and 12 years were studied in two groups of 30 each as laryngeal mask airway group (LMA group/ group A) and Endotracheal tube intubation (ETT group/ group B). The data of both the groups were compiled and statistically analysed using Student ‘t’ test and p value was calculated. The IOP in LMA group was not raised during and after insertion of LMA. And remained progressively less at 30 seconds and 2 minute of study. In ETT group, the IOP had an initial fall after induction and later rose at 30 seconds 2^{nd} minute of intubating the trachea. ($P<0.001$). Statistically the rise in IOP was highly significant. The heart rate in LMA group showed a declining trend during an after induction, insertion and throughout the study. Whereas in ETT group after induction, there was an initial fall in heart rate from the baseline value. Then at 30 seconds and 2 minutes of insertion of tracheal tube the heart rate had progressive increase ($p<0.001$) In LMA

group the systolic & diastolic blood pressure are decrease from its baseline value, after induction, during insertion and at 30 seconds and 2 minute of insertion. But blood pressure remained within physiological limits. 70 In ETT group ,the systolic & diastolic pressure had an initial fall after induction and later on showed a rising trend at 30 seconds and 2 minutes of insertion of endotracheal tube.($p<0.001$)

Hence this study is in favor of use of LMA to a conventional use of endotracheal for administrating general anaesthesia specially for haemodynamically compromised patients and intraocular surgeries. Laryngoscopy and tracheal intubation is a time-tested method to achieve the airway control in anesthesia practice and resuscitation. However, it is associated with significant rise in IOP and cardiovascular response in the form of raised blood pressure and tachycardia because of sympathetic discharge following laryngotracheal stimulation . Many workers have made attempts in the past to mitigate or prevent cardiovascular and ocular reactions especially the acute increase in intraocular pressure (IOP) associated with laryngoscopy and endotracheal intubation. Use of Brains' laryngeal mask airway (LMA) as an alternative to endotracheal tube has attracted the attention of several workers with regard to haemodynamic and IOP changes.

CONCLUSION

1) Air way can be secured with confidence by LMA

2) The art of placing LMA can be learnt very easily

3) There is no difficulty in maintaining the anesthesia at desired level

4) Patient tolerance to LMA is very good

5) The IOP does not raise when LMA is used hence can be safely used in patients with already raised IOP like in Glaucoma and in penetrating eye injuries.

6) Endotracheal intubation is associated with rise in IOP, heart rate, and blood pressure.

7) Reusable LMA is cost effective when compared with ETT since a single reusable LMA can be used uptill 20 times after ETO sterilization.

8) LMA can be used safely in patients who are haemodynamically compromised

The present study concludes that use of LMA as more beneficial when compared to ETT for general anesthesia in the group of patients studies